Subject: Re: crossover point
Posted by Duke on Fri, 13 Jun 2008 23:45:07 GMT
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Again, thanks for asking for clarification.The radiation pattern of a direct-radiator driver depends on how physically wide the driver's diaphragm is compared to the wavelengths being reproduced. If the diaphragm is more than 1/2 wavelength wide, it will start to "beam" - that is, the radiation pattern will start to narrow. Let me try to explain why beaming occurs. Let's assume we have a 5" diameter cone that is reproducing a sine wave at 1350 Hz, so at this frequency the cone diameter equals 1/2 wavelength (sound travels 13500 inches per second, so one wavelength at 1350 Hz is 10 inches long). The sound from the right-hand edge of the cone actually radiates in all directions, including straight across the cone towards the left-hand side. But by the time it gets to the left-hand side, which is 1/2 wavelength away, the left-hand side of the cone is now moving exactly out-of-phase with the sound that originated on the right-hand side. So, it gets cancelled. This is happening all across the surface of the cone. As a result, less energy is radiated to the sides of the cone than out in front of the cone. The higher up in frequency we go the narrower that main frontal lobe becomes (though we do get some side-lobes at higher frequencies). So let's take a hypothetical speaker with a 6.5 inch woofer and a 1" dome tweeter, crossed over at 2700 Hz. The actual cone diameter of the woofer is about 5 inches. At this crossover frequency, a sound wave is 5 inches long . Our woofer's diameter is thus one wavelength at the crossover frequency, so the woofer will be beaming - in this case it's radiation pattern will be roughly 90 degrees wide (that's not a "brick wall" at 90 degrees; the anechoic sound pressure level will be down by 6 dB by the time we get to 45 degrees to either side of the centerline.) Now our 1" dome tweeter's diameter is much less than 1/2 wavelength, so its pattern will be very wide. In fact, it will probably want to be close to 360 degrees (omnidirectional), but the front baffle of the enclosure acts as a 180 degree "horn" and confines its radiation to a 180 degree angle (this assumes the tweeter is not mounted in virtually free-air atop the enclosure, like on some B&W speakers).Very few driver manufacturers publish polar response plots of their drivers, but prosound manufacturer Selenium of Brazil does. At the link below you'll find the spec sheet for one of their 12" woofers. Note that the radiation pattern narrows as we go up in frequency until we get to 3.125 kHz - where suddenly, the pattern widens! The reason is cone break-up; now the cone is flexing severely, and acting as if its diameter is much smaller than it really is. Note also that in the 2 kHz plot we see side-lobes starting to form. Finally, the Selenium woofer's pattern is generally wider than rigid piston theory would predict even below well 3.125 kHz, and this is because the cone is not perfectly rigid so some flexture is occuring. Let's look as some implications of this beaming phenomenon. At low frequencies the woofer diameter is much smaller than a wavelength so the bass will be omnidirectional. At 13,500 Hz the tweeter's diameter if equal to one wavelength, so its radiation pattern will be about 90 degrees at that frequency, and will continue to narrow as we go up higher. What about an MTM? Well, the vertical woofer arrangement will result in beaming setting in in the vertical plane at a much lower frequency than in the horizontal plane. And look at the traditional sideways MTM used for a center channel - now the dual-woofer beaming is in the horizontal plane! This is exactly what you don't want - you want the center channel to have correct tonal balance for everyone in the room, but instead it's now the speaker whose tonal balance changes the most with different listening positions. Let's look at a ribbon tweeter, with its relatively tall, narrow diaphragm. A ribbon will have a very wide radiation pattern in the horizontal plane, but will beam badly at high frequencies in the vertical plane. Well I've probably rambled enough. Hope this helps. And if I've made any mistakes here, I welcome correction or

clarification.Duke
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